METAL MINING — BUILDING BLOCK PROFILE

Prepared for:

Economic Development Branch
BC Ministry of Sustainable Resource Management

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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: http://srmwww.gov.bc.ca/rmd/ecdev/

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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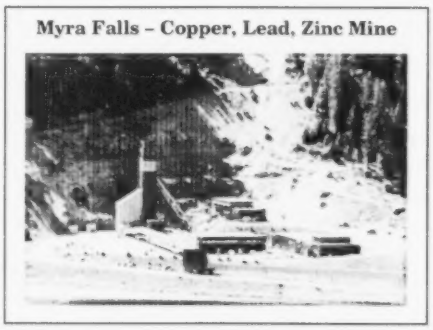
1.0 OVERVIEW

1.1 Description

- BC encompasses the largest part of the Canadian Cordillera, a mountain belt rich in minerals and coal – mining began in the mid-1800s, and since then BC has become one of the world's major mining regions.
- BC is an important producer and exporter of copper, gold, silver, lead, zinc, molybdenum, coal and many industrial minerals.
- BC is known for its high quality metallurgical coal, its large open pit copper-molybdenum and copper-gold porphyry deposits – world-class examples, include the Sullivan lead-zinc mine (closed in 2001), the Highland Valley copper mine and the rich Eskay Creek silver-gold deposit in Northwest BC.
- Vancouver is one of the great mining centres in the world – the Canadian mining industry is internationally recognized for its leading expertise in mineral exploration and mine development.

1.2 Metal Mine Process Description

- Mining requires ore extraction, transport to the crushing plant, crushing, grinding, ore separation and concentration, tailings disposal, drying of the metal concentrate, and shipping concentrate to market.
- Metal mines usually produce a concentrate – for smaller operations (e.g., gold mines), higher value is generated at the mine with the production of metal from the concentrate.


Myra Falls – Copper, Lead, Zinc Mine

1.3 Scale of Operation

- Mine development is reviewed here in terms of three scales of operation.
- Case A: – A small remote (with little or no infrastructure) underground gold mine in the Central Coast, Omineca or Chilcotin regions, processing 500 tonnes/day of ore – a remote site would require fly in/ fly out access, which increases costs.
- Case B: – A large underground copper-lead-zinc-gold polymetallic mine (i.e., multiple metals) in the Central Coast or Northeast region, processing 3,000 tonnes/day of ore.
- Case C: – A large open pit copper-gold porphyry mine in the North central or Chilcotin regions, processing 60,000 tonnes/day of ore.

CASE A: Small Underground Gold Mine

- A small underground gold mine generally produces gold dore (i.e., a gold-silver bar) for shipment to an offshore refinery.
- The project would include a small underground mine with an underground shaft, a hoist, a small concentrator, leaching equipment, gold stripping, electrowinning and smelting equipment to produce gold bars (Appendix 1 presents a typical gold flotation, leaching, concentrator block flow diagram).

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- Infrastructure would normally include access roads and power supply, tailings disposal facility, waste rock dumps, camps, warehouses, repair shops and offices.

CASE B: Large Underground Polymetallic Mine

- Underground mining of a polymetallic ore body, such as copper, lead, zinc and gold, would produce a concentrate for shipment to a BC based smelter, such as Teck-Cominco's facility at Trail.
- The project would include a large underground mine, shaft or ramp, underground ore crushing, hoists, a concentrator (Appendix 2 presents a typical polymetallic concentrator block flow diagram).
- Infrastructure would normally include access roads and power supply, tailings disposal facility, waste rock dumps, camps, warehouses, repair shops and offices.

CASE C: Large Open Pit Copper Mine

- Case C covers mining of a porphyry copper-gold type ore body – the project would include a large open-pit mine, a large crushing plant, a concentrator including concentrate filtering and drying facilities (Appendix 3 presents a typical copper concentrator block flow diagram).
- Infrastructure would normally include access roads, power supply, tailings disposal facility, waste rock dumps and ancillary facilities such as camps, warehouses, and repair shops and offices.
- For a remote mine site – a 700-metre airstrip suitable for Boeing 737 or Hercules aircraft would also be needed.

Highland Copper Mine
Example Large Open-Pit Mining Operation

Mine Development

- Mine development typically involves five major phases: (1) Exploration and Development. (2) Mine Construction), (3) Mine Operation (4) Closure (5) Site Rehabilitation.

Exploration and Development

- Exploration typically takes 5 to 10 years and involves remote geophysical techniques (e.g., satellite images, airborne gravimetric surveys, geological mapping, IP surveys), which identify high potential targets.
- Land-based activities include diamond drilling, geochemistry, exploration adits (tunnels), trenching and sampling, assaying – these activities seek information to justify further development expenditures, normally leading to a pre-feasibility study.
- Detailed exploration proceeds to build further confidence to support a project – this requires more diamond drilling, bulk sampling, metallurgical testing, pilot plant work and the preparation of a feasibility study to justify the project financing decision.
- For the exploration and development phase, there is a progression in terms of land use, from small multiple targets spread over a large area to smaller areas of more intensive work.

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Design and Construction

- This step involves detail design and construction of the mine (e.g., 1 to 3 years), involving – access, improvements, site preparation, engineering, procurement, construction, commissioning and start-up.

Operation

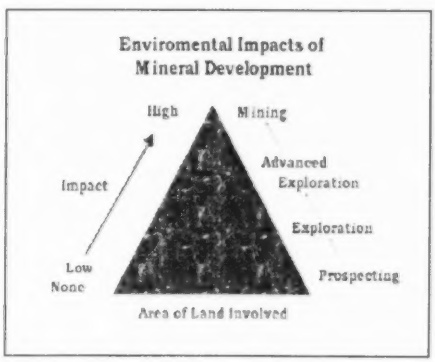
- Mine operation (e.g., 10 to 30 years) includes mining, milling, waste rock and tailings, environmental monitoring, inspection and enforcement, including, water quality, (e.g., acid rock drainage management), air quality, and fish and wildlife management.
- During its operation the mine supports a wide range of suppliers, including electricity, utility suppliers, camp supplies, equipment, vehicles, conveyors, food, fuel, chemicals, airstrip and air service, in addition, access road maintenance often can help others (e.g., forestry, recreation, prospectors).
- During operation – exploration continues to find new reserves and to extend and maximize mine life.

Closure and Reclamation

- Following the mine's operating life, the next phase is preparing for closure (1 to 2 years) – much of the planning for closure begins in the early permitting phase and throughout the mine's operating life – closure includes plant resale/relocation, demolition, and preparing for managing long-term acid rock drainage (ARD), where ARD is an issue.
- Rehabilitation (e.g., 1 to 4 years) replaces the site with equal or better land condition than prior to mining, which normally involves filling and grading, pit or mine stabilization, tailings impoundment reclamation, acid rock mitigation – reclamation bonds, are required to be put in place by mining companies to ensure rehabilitation achieves the pre-determined environmental objectives (e.g., wildlife habitat, visual quality, grazing areas, etc.)

2.0 RESOURCE SENSITIVITIES

- The business of the mining industry is to supply the metals and minerals needed in our society – the nature of mining requires that land, air and water systems be temporarily disturbed – the challenge for mining companies is to do this with the least possible disruption to these systems.
- Given the broad geographical dispersion of mineral deposits in BC, large tracts of land must be available to the mining industry for exploration.



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- Although large areas of land are required to find mineral prospects, only about 1 in 5,000 mineral prospects in Canada ever becomes a mine[2]
- In BC, less than 1/30th of 1 percent of BC's land base (28,000 hectares) is currently being used for mining. [3]

Sensitivities

Depending on the location and conditions of the site the following sensitivities may apply :

Environmental	Economic	Social
➤ Ground disturbance, loss of tree and plant cover. ➤ Water use and discharges from surface erosion, product washing. ➤ Groundwater impacts. ➤ Fish and wildlife habitat impacts. ➤ Acid rock drainage issues.	➤ First Nations rights. ➤ Trucks wear on roads serving the operation. ➤ Tourism and commercial recreational impacts.	➤ Community impacts – employment, spin-off business impacts. ➤ First Nation impacts (e.g., (trapping, potential employment) ➤ Visual aesthetics and recreational impacts ➤ Truck traffic on resource roads shared by others.

- Due to their relative remoteness, metal mines do not normally have major social impacts related to populated areas, such as complaints about noise from blasting, crushing screening, back up alarms, visual aesthetics, dust from pit and trucks – these are often issues with quarry operations near populated areas.
- To address these issues, mining companies have had to adopt sensitive environmental practices during exploration, development and operation for the mining and metallurgical processes through to the final decommissioning and land reclamation phase over the life-cycle of the mine.
- Mining operations represent a temporary land use – when operations are completed, reclamation can restore the land to its earlier condition and in some cases create higher-valued land uses, such as enhanced wildlife habitat.

Reclaimed Tailings Pond

3.0 INVESTMENT REQUIREMENTS

- Using the three examples of metal mine developments – investment requirements can be broken down into five developmental stages, exploration and development, mine and processing plant design and construction, operation, closure, rehabilitation.
- Typical investment requirements by each of the mine life-cycles, based on a various mine lives, are shown below:

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Development Phase	CASE A Small Underground Mine[4]	CASE B Large Underground Mine [5]	CASE C Large Open Pit Mine [6]
Commodity	Gold Silver	Lead-Zinc-Silver	Copper- Gold
Processing Capacity (tonnes/day	500	3,000	60,000
Operating Employment	110	335	405
Exploration and Development ($' M) [7]	9.0	27.0	18.0
Design and Construction ($' M)	42.0	296.0	440.0
Operating Costs ($/tonne) [8]	76.0	$57.00/tonne milled	$4.41/ tonne milled
Offsite Handling And Shipping Costs		$75.00/ tonne shipped	$75.00/ tonne shipped
Ongoing Capital Costs ($' M, life))	2 (5 years)	16 (15 years)	69 (20 years)
Closure Costs ($' M) [9]	4.0	15.0	20.0
Rehabilitation Costs ($' M)	2.0	5.0	5 + 1/year In perpetuity

4.0 INFRASTRUCTURE

CASE A: Small Underground Gold Mine

- A typical mine in this class could have an all weather road access, perhaps 70 km from the Provincial road system – these roads will be used for the transportation of bulky equipment, materials and consumables for both construction and operation – gold dore and personnel will be transported in and out by air.
- The small size and relatively short mine life for these types of high-value mines dictate the use of a remote diesel or hydro electric generating power plant, or if in close proximity to the power grid a tie-in from the grid – for the remote generating case large amounts of diesel fuel would have to be transported to site.
- The smaller employment requirements of these mine types allow for the use of local personnel for most tasks – training may be required if the skills required are not available in the local area.
- Processing on site (to dore bullion) reduces transportation costs, however the higher value of the product requires greater security (charter aircraft are generally used for product shipment).

CASE B Large Underground Mine

- A typical mine in this class could have forest road type access, perhaps 20 km from the Provincial road system – concentrate will be shipped out by road or for coastal sites by barge or ship.
- The size and longer-term commitment of these types of mines require the construction of power and water infrastructure – power may be obtained from a small hydro facility or from long overhead power lines.
- The remote nature of the mine sites requires that the workforce work 4 in 4 out shifts with 12 hour shifts – the workforce are transported to site by ground transport from nearby towns (e.g., Prince Rupert, Smithers, Kamloops).

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- Lead zinc concentrate is shipped by road or by barge, to a railhead or port for transshipment prior to export or to the Trail smelter for local processing.

CASE C Large Open Pit Copper Mine

- A typical mine in this class could have forest road type access perhaps more than 100 km from the Provincial road system – these roads will be used for the transportation of bulky equipment, materials and consumables for both construction and operation – concentrate would be shipped out by road or for coastal sites by barge or ship.
- The size and longer-term commitment for these types of mines typically require the construction of major power and water infrastructure.
- The remote nature of the mine sites requires that the workforce work 4 in 4 out shifts with 12 hour shifts, similar to the large underground mine case.
- Copper concentrate is shipped by road or barge, to a railhead or port for transshipment prior to export generally to Asian smelters.

5.0 MARKETS

- Decisions to invest in large mines require commitments often measured on a time scale of decades.
- Marketing of mineral concentrates starts at the pre-feasibility and feasibility stages of mine development – mining companies seek forward contracts with smelters to supply them with specific concentrate.
- Concentrate quality is of great significance for the smelters and penalties are charged for undesirable inclusions (e.g., bismuth and antimony) – on the other hand, credits are paid to the mine for desirable byproducts, such as for gold, silver and sulphur.
- Generally the metal mine output will be a concentrate containing between 25 percent to 55 percent metal by weight.

Gold

- Most gold mines will refine the product on site to metal dore bullion – others may ship whole ore (Eskay Creek) or refractory concentrate to hydrometallurgical refiners, such as Miramar's Con Mine in Yellowknife, or other facilities in Canada or offshore.

Lead - Zinc - Molybdenum

- Generally the product of lead-zinc mines will be a lead concentrate containing 55 to 60 percent lead by weight, and zinc concentrate containing 50 percent zinc by weight.
- Some BC mines such as Huckleberry (near Smithers) produce molybdenum as a by-product, along with copper and silver – the Endako Mine (near Fraser Lake) is a major BC producer of molybdenum – molybdenum is used in the iron and steel industry and as a lubricant.
- These concentrates are shipped from the mine by road, rail or barge to smelters, either to the Trail smelter or overseas.

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Copper

- Generally copper concentrate contains about 30 percent metal by weight – concentrates are shipped from the mine by road, rail or barge to smelters overseas – much of BC's copper concentrate is exported to Japan.
- Copper is used largely for electrical wiring, plumbing fixtures and roofing – copper demand is driven by economic growth and price determined by the interaction of world supply (e.g., major competing suppliers) and demand.
- The outlook for copper in the long term is relatively positive and is tied to the economic recovery of the world's developed economies.

Export Markets

- The 1997-98 Asian depression (i.e., the "Asian Flu") depressed Asian metals markets, which has had lingering effects – Chinese markets have shown some recovery in 2002, however this has not improved the demand for copper and price has declined from 2001 to 2002, as indicated in the table below.
- Currently, copper is in abundant supply – new large mines have been brought on stream such as the 70,000 tonne/day Antamina copper/zinc mine in central Peru, Newmont mining Corporation's Batu Hijau mine in Indonesia, Falconbridge's Collahausi copper mine and the Escondia copper mine, both in Chile.

BC Mineral Values

- Several key metal prices and net revenues as reported by the PriceWaterhouseCoopers annual survey of selected companies, which represent the BC mining industry, are reported below:[10]

Metal	2000		2001	
	Price	Net Revenues	Price	Net Revenues
	($US)	($C million)	($US)	($C million)
Copper	0.82/lb.	485.0	0.72/lb	512.0
Lead	0.44/lb	66.0	0.44/lb	39.0
Zinc	0.51/lb	507.0	0.41/lb	244.0
Silver	4.95/oz.	179.0	4.37/oz.	149.0
Gold	279.0/oz.	274.0	271.0/oz.	248.0
Other (Molybdenum, Power	N/A	294.0	N/A	460.0

Value of Production

Using the three general mine examples:

CASE A: Small Underground Gold Mine [11]

- Ore processed at 500 tonnes/day.
- Grade of ore = 10 grams gold/tonne = 5,000 gm/day x 90 percent recovery = 4,500gm/day
- Grade of gold bullion = 99.0 percent.
- Value of gold bullion @ US$300.00/ounce = approx. US$48,000/day.

- Mine in production 350 days per annum.
- Production value $C27.0 million/yr. [12]

CASE B: Large Underground Copper-Lead-Zinc-Gold Mine [13]

- Ore processed at 3,000 tonnes/day.
- Grade of ore: Copper 3.0 percent, Lead 1.5 percent, Zinc 9.5 percent, Gold 1 gm/tonne, Silver 20gm/tonne.
- Grade of concentrate: Copper 26 % percent, Lead 60 percent, Zinc 55 percent Min.,
- Recovery: Copper 88 percent, Lead 90 percent, Zinc 75 percent, Gold 75 percent, Silver 75 percent
- Total tonnage of concentrate: Copper 305 tonnes/day, Lead 67 tonnes/day, Zinc 390 tonnes/day, Gold 2,250 gm/day (60 percent in copper concentrate, 40 percent in lead concentrate.), Silver 45,000 gm/day (40 percent in copper concentrate, 60 percent in lead concentrate.)
- Value of concentrate [14] [15]

Copper	305 tonnes/day @ US$ 280 /tonne	US$ 85,260
Lead	67 tonnes/day @ US$ 364 /tonne =	US$ 24,536
Zinc	390 tonnes/day @ US$ 236 /tonne =	US$ 92,196
		US$ 201,992
	Shipping 762 tonnes at $50.00 / tonne	(US$ 38,100)
	Value Of Concentrate Shipped	US$163,892 / day

- Mine in production 350 days per annum
- Total $C92. 0 million/yr.

CASE C: Large open pit copper-gold porphyry mine [16]

- Ore processed at 60,000 tonnes per day
- Grade of ore: Copper 0.5 percent, Gold 0.5 gm/tonne.
- Grade of concentrate: 27.0 percent
- Recovery: Copper 92.0 percent, Gold 75.0 percent
- Total Tonnage Concentrate: [17] [18] Copper 1000 tonnes/day, Gold 22,500 gm/day in copper concentrate.
- Value of concentrate @ US$ 416.00/tonne = US$ 415,000/day
- Mine in production 50 days per annum
- Total $C232. 0 million/yr.

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6.0 LABOUR MARKET

6.1 Skill Requirements

- New mines have a high degree of automation and process control requiring fewer, but more highly skilled, operators.
- Mining workers are well paid (average BC wage is $81,100/yr.[19].) and highly mobile – workers laid off from one operation are likely to find employment at another within a short time.
- The construction of new mine townships would be rare, however the use of an existing community greatly helps the economics of new mines with less requirement for camps, more flexibility on shift working, lower cost for worker transit, etc.
- Some mines such as the Golden Bear mine in northern BC are operated on a seasonal basis – Golden Bear is a gold heap leaching operation that is operated only during the summer months.
- It is estimated that in 2001 there were approximately 4,800 people directly employed in metal mines in BC (includes head office and Trail refining operations)[20] – total employment, including direct, indirect and induced employment is estimated to be 10,930 workers, based upon the BC Input-Output Model employment coefficients.

Region	Workers
Kootenay	2,256
Okanagan	1,038
North Coast	113
Coast, Cariboo	682
Nechako	558
Northeast	105
Other	70
Direct Employment	4,822
Indirect Employment[21]	4,048
Induced Employment	2,060
Total Employment	**10,930**

6.2 Small Underground Gold Mine

- Exploration and Development (applies to all mining cases) – 5 to 10 year period (requires aerial and ground-based surveying, diamond drilling, metallurgical testwork, pre-feasibility work, bulk sampling, feasibility study, pilot plant, environmental assessment studies and permitting, planning and approvals) requires a diversity of technical skills.
- Mine and plant construction – 8 months, requires 70 workers for mine development and 100 workers for the process plant.
- Mine operation – 10 years requiring 110 workers.[22]
- Closure – 1 to 2 years requiring 50 workers for 6 months for dismantling and closure preparation, 20 workers for 18 months
- Rehabilitation – 4 years, requiring about 10 workers.

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6.3 Large Underground Mine

- Mine and plant construction – 2 years requiring 100 workers for mine development and 200 workers for the process plant for 18 months.
- Operation – 20 years requiring 335 workers.[23]
- Closure – 2 years dismantling requiring 50 personnel for 6 months closure preparation requiring 20 workers for 18 months.
- Rehabilitation – 4 years requiring 10 workers.

6.4 Large Copper Mine

- Mine and plant construction – 30 months for open pit pre-stripping, 60 workers for 6 months, and process plant 300 workers for 30 months.
- Operation –30 years requiring 405 workers.[24]
- Closure – 2 years dismantling requiring 60 personnel for 6 months and UG closure preparation requiring 20 personnel for 18 months.
- Rehabilitation – 4 years requiring 20 workers.

7.0 CAPACITY

- BC is rich in mining potential and has a large number of undeveloped minerals deposits, with approximately 12,000 to14,000 known mineral occurrences.[25]

Copper

- Of the more than 100 known copper deposits in BC, there are a number of large porphyry copper deposits in an advanced stage of exploration – these are located generally in a northwest trending belt extending from Prosperity (Fish Lake north of Taseko Lake) in the Chilcotin to the Omineca/Cassiar region (Red Chris and Kemess North).

Gold

- The majority of the new gold production will come from the porphyry copper deposits (e.g., Mount Milligan, Red Chris and Kemess North).
- The potential for gold vein deposits (e.g., Cheni and Bralorne) and the massive sulphide deposits (e.g., Eskay Creek) are also high in BC, with more than 100 known undeveloped deposits.
- There is a high probability of future gold mines in the vicinity of old gold mining areas (e.g., Barkerville, Bralorne).

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Lead, Zinc and Silver

- There is also the potential for a new lead-zinc- silver mine from Sedex (e.g., Sullivan type of mine), VMS (e.g., Myra Falls, Eskay Creek type) and metamorphic sedimentary deposits (e.g., Broken Hill type).
- Prospective areas range from: Kimberley and further south to the US border in Southeast BC; a broad north westerly trending belt, continuing to the Kechika Trough and Yukon border in northern BC; and other areas for possible development include the Coast and Vancouver Island.

Others

- In addition to these base and precious metals, there are a number of known molybdenum, platinum group metals, industrial minerals and gem stone deposits throughout BC.

8.0 REGULATORY REGIME

8.1 Provincial Approvals

- The *Environmental Assessment Act* established BC's environmental review process, coordinated by the Environmental Assessment Office, which reviews the potential environmental, social, economic, cultural, and heritage impacts of large-scale development projects.
- Reviewable projects include metal, mineral coal and placer mines, aggregate operations, and industrial quarries, in addition to related processing of primary metals, minerals and mineral products and manufacturing (cement, glass, lime and asbestos).
- The BC environmental review process accommodates simultaneous review of the required permits and licences – application of permits and licences may need to incorporate detailed engineering design information, which may be difficult to justify without first approving approval-in-principle through environmental assessment approval.
- Provincial statues and regulations[26] that may apply to mining operations, include: the *Mines Act* (Health, Safety and Reclamation Code), *Forest Land Reserve Act*, *Forest Act*, *Range Act*, *Forest Practices Code Act*, *Soil Conservation Act*, *Agricultural Land Reserve Act*, *Land Act*, *Highway Act*, *Water Act*, *Heritage Conservation Act*, *Environmental Assessment Act*, *Fish Protection Act*, *Waste Management Act*, *Wildlife Act*.
- Timelines for the government portion of BC environmental assessment review is set out in regulation – the length of the review process depends on the complexity of the issues and could range from 12 to 30 months, or longer if a public hearing is required

8.2 Federal Approvals

- When a large-scale project triggers the *Canadian Environmental Assessment Act*, the BC and Federal governments have agreed to co-operate in a joint review process – at the end of a Federal-Provincial review, each government makes a separate decision on the project.
- Federal involvement can be triggered when projects require interprovincial, international or federal approvals, or which receive federal financial assistance, or involve federal lands.

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- Federal statues and regulations[27] that may apply, include: the *Fisheries Act*, *Canadian Environmental Assessment Act*, the *Navigable Waters Protection Act*, *Canadian Environmental Protection Act*, *Migratory Birds Convention Act*, *Canada Wildlife Act*.

8.3 Local Approvals

- Typical metal mine operations are not located in local government jurisdictions; however if they are, local government can affect operations through application of local bylaws that can affect emissions, soil removal, hours of operation, noise, truck transport routes, and other operating conditions.
- If a new mine is located near an existing community, the boundaries are often enlarged in order to capture a new tax base for the benefit of the local community.

9.0 GOVERNMENT REVENUES

The following table lists the various local, provincial and federal taxes and levies paid by the surveyed companies representing the BC mining industry (included is the coal industry which represents 37 percent of BC's net revenues) from the PriceWaterhouseCoopers annual review of the BC mining industry for 2001.[28]

Component	Government Revenues
	($ million)
Local Taxes	
School Tax	10.0
Municipal Finance Authority	12.0
Rural Area Levy	8.0
Other Levies	12.0
Sub-Total	**42.0**
Provincial	
Corporate Income Tax	34.0
Employee Income Taxes ($81k/worker, 7,630, 7%)	43.2
Mining Taxes	7.0
Mineral Tax	25.0
Capital Tax (Phased out)	7.0
Provincial Sales Tax (7.5%)	34.0
Fuel tax	9.0
Other	3.0
Sub-Total	**162.2**
Federal	
Employee income taxes ($81k/worker, 7,630, 14%)	86.5
Corporate Income taxes	30.0
Goods and Service Tax and Other	16.0
Sub-Total	**132.5**
Total	**336.7**

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- Mining companies are subject to fees and taxes, similar to other businesses – the main additional charges are mining and mineral taxes.
- With the addition of employment income tax, which accrues to the Provincial and Federal governments, the BC mining and mineral industry contributed an estimated $336.70 million in government revenues in 2001.

10.0 INPUT-OUTPUT TABLE

10.1 Value Coefficients

- BC leads Canada in the production of copper, valued at over $730 million in 2000, representing over 40 percent of Canada's total production – BC produces 50 percent of Canada's silver and a significant amount of Canada's gold production.[29]
- According the BC Mining Association, mining an ore body in BC represents the highest value to which a hectare of resource land could be put:[30]

Resource Land Use	Value
Gross Annual Value	($/hectare)
Mining	$150,000
Forestry	$5,700
Agriculture	$1,400
Parks and Recreation	$42.00

- In total, less than 0.03 percent on BC's land base is used for mining (i.e., 28,000 hectares) – this compares to about 200,000 hectares *per year* that was harvested by the forest industry in 1996-97.[31]
- Over the last 10-years, two mines have closed for every new mine that has opened [32]

10.2 Employment Coefficients [33]

- The BC Input-Output Model provides employment coefficients for some of the major components of the BC mining industry.
- As shown below, the total employment (see definition below) ranges from a high of 12.4 jobs per $1,000,000 in revenues to a low of 3.7 jobs per $1,000,000 in revenues.

Employment/million sales /yr	Direct	Indirect	Induced	Total
Gold Mines	1.40	1.68	0.66	3.74
Other Metal Mines	4.05	3.40	1.73	9.18
Service Incidental to Mining	7.89	2.41	2.09	12.39

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- Direct Employment – is the employment associated with the direct activity.
- Indirect Employment – is the employment generated within the BC economy from suppliers of the materials (goods and services) required to produce the primary product.
- Induced Employment – is generated from the suppliers paying out wages to their employees, which are then respent in the economy (net of savings and taxes).
- Total Employment – is the sum of this total economic activity, (i.e., direct and spin-off impacts) composed of three components (direct, indirect and induced).

10.3 Labor and Capital Intensity

- The employment coefficients above reflect the relative labor intensity of the industrial mineral activity – the low labour intensity of metal mines reflects high capital intensity in the industry – which generates higher labor productivity and supports the high wage rates typically of the industry (e.g. $81,000/yr. BC average).
- Firms attempt to equalize the productivity from both capital and labor, which allows them to stay competitive and sustain operations (e.g., protect employment) during the ups and down of the commodity price cycle.

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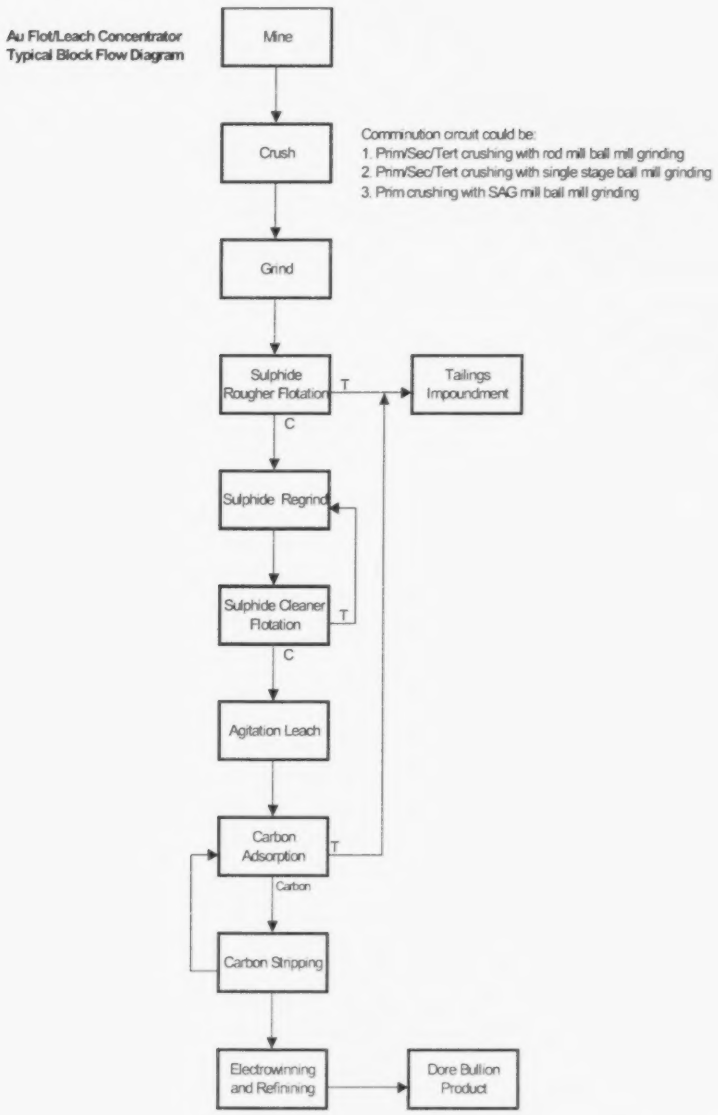
APPENDIX 1: TYPICAL GOLD FLOTATION, LEACHING, CONCENTRATION BLOCK FLOW SCHEMATIC



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APPENDIX 2: TYPICAL COPPER, LEAD, ZINCS CONCENTRATION BLOCK FLOW SCHEMATIC

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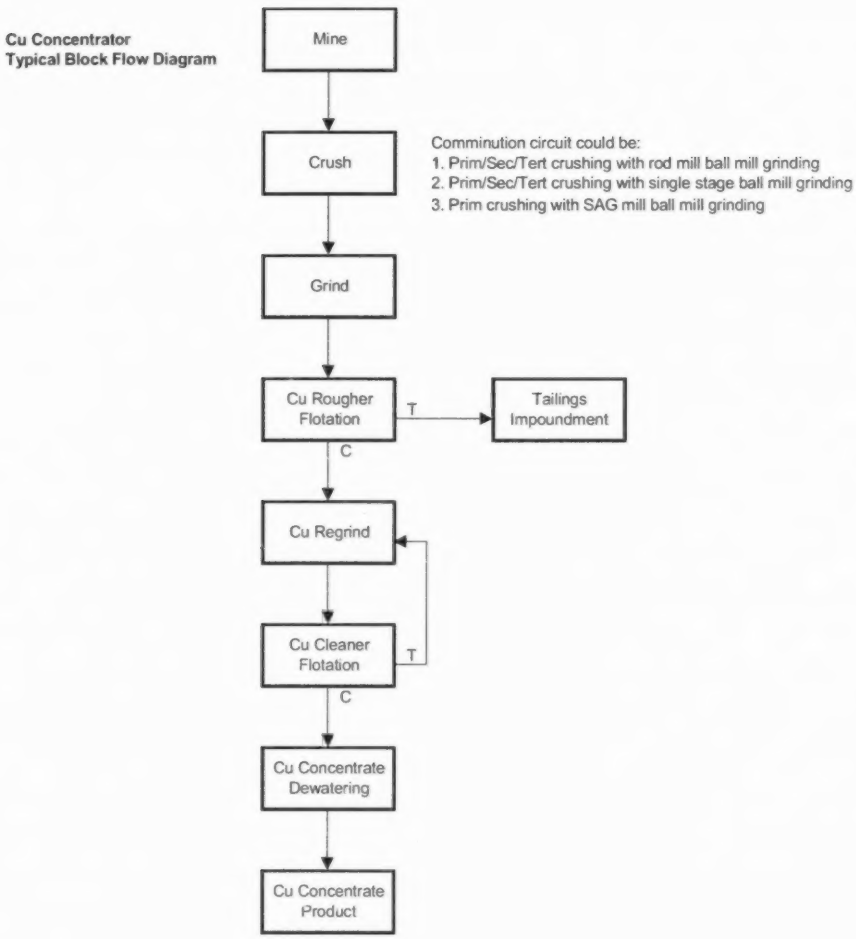
APPENDIX 3: TYPICAL COPPER CONCENTRATION BLOCK FLOW SCHEMATIC



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SOURCES OF INFORMATION

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[1] This Building Block is one of five prepared under the *Minerals, Coal and Aggregates Building Block* heading, which covers Construction Aggregates, Industrial Minerals, Metal Mines, Coal and High Valued Opportunities.

[2] British Columbia and Yukon Chamber of Mines. http://www.bc-mining-house.com/land/landuseoverview.htm.

[3] Mining Association of BC http://www.mining.bc.ca/quickfacts.htm

[4] Confidential Feasibility Study for 500tpd gold underground mine in BC– Fluor Daniel Wright Ltd. Escalation Cost Indices based on Marshall and Swift Index for Mining and Milling.

[5] Confidential Feasibility Study for 3000tpd copper, lead zinc underground mine– Fluor Daniel Wright Ltd. Escalation Cost Indices based on Marshall and Swift Index for Mining and Milling.

[6] Confidential Feasibility Study for 60,000tpd copper open pit mine in BC – Fluor Daniel Wright Ltd. Escalation Cost Indices based on Marshall and Swift Index for Mining and Milling.

[7] File Note: Personal Communication from John Tully, P.Eng. October 30th, 2002 Re: Exploration Costs

[8] 2001 Mining Sourcebook – Canadian Mining Journal

[9] Normally, closure costs are offset by salvage value at the mine. However, in today's market there is very little salvage value in equipment.

[10] http://www.mining.bc.ca/download/mibc_2001.pdf, Appendix 4 & 7.

[11] Confidential Feasibility Study for 500tpd gold underground mine in BC– Fluor Daniel Wright Ltd.

[12] Exchange Rate US1.00 = CA$1.60 used throughout this document.

[13] Confidential Feasibility Study for 3000tpd copper, lead zinc underground mine– Fluor Daniel Wright Ltd.

[14] File Note: Personal Communication from Jack Butterfield, October 30th, 2002 Re: Smelter Charges.

[15] Mining Investment Strategy: Criteria for Decision Making in Market Based Economies, May 1993

[16] Confidential Feasibility Study for 60,000tpd copper open pit mine in BC – Fluor Daniel Wright Ltd.

[17] Mining Investment Strategy: Criteria for Decision Making in Market Based Economies, May 1993

[18] File Note: Personal Communication from Jack Butterfield, October 30th, 2002 Re: Smelter Charges.

[19] http://www.mining.bc.ca/download/mibc_2001.pdf, Appendix 17.

[20] http://www.mining.bc.ca/download.mibc_2001.pdf Appendix 20 (less regional coal mining employment).

[21] BC Ministry of Finance and Corporate Relations (2001), ***British Columbia Provincial Economic Multiplies and How to Use Them***. Other Metal Mines, Large Aggregation. This multiplier chosen as an average.

[22] Confidential Feasibility Study for 500tpd gold underground mine in BC– Fluor Daniel Wright Ltd.

[23] Confidential Feasibility Study for 3000tpd copper, lead zinc underground mine– Fluor Daniel Wright Ltd

[24] Confidential Feasibility Study for 60,000tpd copper open pit mine in BC – Fluor Daniel Wright Ltd.

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[25] http://www.em.gov.bc.ca/dl/Mining/Exploringthefuture/IndustrialMinerals.pdf.

[26] Provincial statutes http://www.qp.gov.bc.ca/statreg/

[27] Federal statutes http://laws.justice.gc.ca/en/index/index.html

[28] http://www.mining.bc.ca/download/mibc_2001.pdf, Appendix 21

[29] http://www.em.gov.bc.ca/dl/Mining/Exploringthefuture/MiningProduction.pdf

[30] http://www.mining.bc.ca/quickfacts.htm. According to the Lorne Grasely of the BC Mining Association (604.681.4321, local 116), this statistic reflects gross annual revenue per hectare.

[31] BC Ministry of Forests ***1997/98 Annual Report*** . Page 90.

[32] BC Mining Association, Quick Facts About Mining. According to the Lorne Grasely of the BC Mining Association (604.681.4321, local116), this statistic was estimated about 5-years ago (e.g. 1997).

[33] BC Ministry of Finance and Corporate Relations (2001), ***British Columbia Provincial Economic Multiplies and How to Use Them.*** Large Aggregation Industries, Induced assumes "with Safety Net".

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